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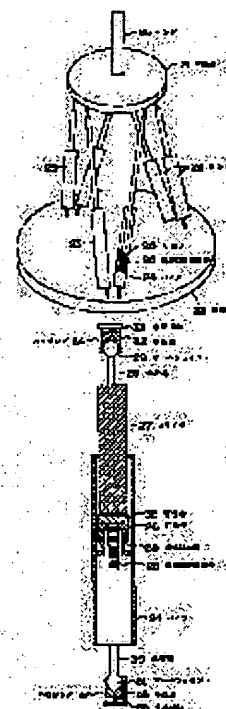
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(54) MICROMANIPULATOR

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a sufficiently large movable range though having high resolving power.

SOLUTION: In a micro-manipulator using a micro parallel link mechanism having six freedom degrees, each link has a pipe 24, piezoelectric element 25, movable piece 26 having an elastic spring leg 39 provided in one end of this piezoelectric element, elastic material 38, and a slider 27, and a direct acting actuator is provided, which drives the slider 27 by the movable piece 26 moved by rapid deformation of the piezoelectric element 25.



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CLAIMS

[Claim(s)]

[Claim 1] It is the micromanipulator characterized by having the direct-acting actuator which the above-mentioned slider drives with the above-mentioned needle which has the needle which has the spring foot on which each link was established in the pipe, the piezoelectric device, and the end of this piezoelectric device in the micromanipulator using the micro parallel link mechanism which has six degrees of freedom, elastic material, and a slider, and is moved by rapid deformation of the above-mentioned piezoelectric device.

[Claim 2] The micromanipulator according to claim 1 characterized by preparing an inertial field in the other end side which has not prepared the needle of the above-mentioned piezoelectric device.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the micromanipulator by the micro parallel link mechanism used in relation, such as a stage of the assembly of minute components, such as a micro machine, an optical-communication component part, and a semi-conductor, welding, micro processing, and a microscope, and the biotechnology relation of cell actuation.

[0002]

[Description of the Prior Art] In the related field of current, optical communication, or a semi-conductor, development of the many degrees of freedom and the highly precise micromanipulator which are small to the detailed assembly equipment which assembles minute optical components and a minute semi-conductor, and have the movable range of [mm (millimeter)] order in it is called for. Especially in such a micromanipulator, having the resolution of (1) dozens [nm (nano meter)] order, two things which can be micrified in order to do an assembly activity under taking [the long stroke more than 1 [mm]] (2) microscope are strong, and it is demanded.

[0003] That is, in the detailed activity, high degree of accuracy and many degrees of freedom need to be positioned, therefore the manipulator of the parallel link mold constituted possible [telescopic motion] by the piezoelectric device prepared in each link of six was proposed.

[0004] The micro parallel link mechanism of the same kind is indicated by JP,6-170761,A, and such a micromanipulator is illustrated to drawing 7 . The parallel link mechanism body is constituted by a movable plate 11, a stationary plate 12, and the links 13 and 13 of six and -- that combine these both here. A hand 14 is formed on a movable plate 11.

[0005] The laminating mold piezoelectric device 15 and the strain gage 16 are included in each links 13 and 13 and --, and the stroke is changed to them with flexible actuation of the laminating mold piezoelectric device 15.

[0006] However, a strain gage 16 can detect the amount of strokes, and a movable plate 11 can perform now relative motion of a total of six degrees of freedom of advancing-side-by-side 3 degree of freedom and rotation 3 degree of freedom to a stationary plate 12 by [of each links 13 and 13 and --] controlling a stroke in cooperation.

[0007] According to such a link connection method, the relative upper location and upper relative posture of a movable plate 11 over the downward stationary plate 12 are controllable by the laminating mold piezoelectric device 15 as an actuator by [of each links 13 and 13 and --] adjusting the amount of strokes.

[0008]

[Problem(s) to be Solved by the Invention] However, in the parallel link mechanism shown in above-mentioned drawing 7 , since flexible actuation of the laminating mold piezoelectric device 15 was used as telescopic motion of a link 13 as it is, while the resolution in control was very high, there was fault that the maximum actuation stroke of displacement, i.e., the amount, will become what also has the movable range small [as 8 [mum] / very] and small as a result of the parallel link mechanism itself.

[0009] This invention was made in view of the above actual condition, and the place made into the purpose is to offer the micromanipulator using the parallel link mechanism which has six degrees of freedom which can take the sufficiently big movable range, having high resolution.

[0010]

[Means for Solving the Problem] In the micromanipulator using the micro parallel link mechanism in which invention according to claim 1 has six degrees of freedom, each link has a pipe, a piezoelectric device, the needle that has the spring foot prepared in the end of this piezoelectric device, elastic material, and a slider, and is characterized by having the direct-acting actuator which the above-mentioned slider drives with the above-mentioned needle moved by rapid deformation of the above-mentioned piezoelectric device.

[0011] Having high resolution, as a result of considering as such a configuration, since the direct-acting actuator which constitutes the link which does not receive a limit in the movable range and connects a movable plate and a stationary plate is small, the whole manipulator can be miniaturized.

[0012] Invention according to claim 2 is characterized by preparing an inertial field in the other end side which has not prepared the needle of the above-mentioned piezoelectric device in invention of the claim 1 above-mentioned publication. Since an adjustable setup of the amount of inertia related to the movement magnitude of the above-mentioned needle can be directly carried out in addition to an operation of invention of the claim 1 above-mentioned publication as a result of considering as such a configuration, an adjustable setup of the amount of flexible steps and flexible rate of the above-mentioned direct-acting actuator can be carried out as a result at arbitration.

[0013]

[Embodiment of the Invention]

(Gestalt of the 1st operation) The micromanipulator of the parallel link mold applied to the gestalt of operation of the 1st of this invention below is explained with reference to a drawing.

[0014] Drawing 1 shows the configuration of the whole and is constituted by the movable plate 21 which carried out installation immobilization of the hand 20, a stationary plate 22, and the links 23 and 23 of six and -- which combine these both.

[0015] The laminating mold piezoelectric device 25 and needle 26 which are later mentioned in a pipe 24 are incorporated, and each links 23 and 23 and -- change the stroke with the needle 26 moved with rapid flexible actuation of the laminating mold piezoelectric device 25.

[0016] Drawing 2 is a sectional view which illustrates the concrete configuration of a link 23, and has the structure where the slider 27 driven to the needle 26 moved by the laminating mold piezoelectric device 25 slides in accordance with the shaft orientations of a pipe 24, within the pipe 24, and a pipe 24 is connected with the stationary plate 22 which is not illustrated through a coupling rod 30 and a swivel joint 31 here again with the movable plate 21 which does not illustrate a slider 27 through a coupling rod 28 and a swivel joint 29 here.

[0017] a swivel joint 29 -- pressurization -- a plate 32 and pressurization -- pressurization is carried out within the housing 34 fixed to the movable plate 21 with the spring 33, and it has come to be able to carry out adjustable [of whenever / champing-angle / with a movable plate 21] smoothly the same -- a swivel joint 31 -- pressurization -- a plate 35 and pressurization -- pressurization is carried out within the housing 37 fixed to the stationary plate 22 with the spring 36, and it has come to be able to carry out adjustable [of whenever / champing-angle / with a stationary plate 22] smoothly

[0018] In the end side of the above-mentioned slider 27, the laminating mold piezoelectric device 25 which inserted the end in the monotonous ring-like needle 26 and the hole of the center of this needle 26 through the elastic material 38 is arranged, as this laminating mold piezoelectric device 25 is covered, the elastic spring foot 39 is formed in a needle 26, and the supporting point which gives frictional force with elasticity between the inner skin of a pipe 24 is constituted.

[0019] However, the direct-acting actuator with which a diameter consists of the slider 27 which is 2 [mm] and was mentioned above to the interior, the elastic material 38, a needle 26, a laminating mold piezoelectric device 25, and an elastic spring foot 39 comes to be contained, and the above-mentioned pipe 24 is held according to the static-friction force of the peripheral face of a needle 26, and the inner

skin of a pipe 24. Moreover, the elastic material 38, the needle 26, the laminating mold piezoelectric device 25, and the elastic spring foot 39 are unified.

[0020] However, if expanding actuation of the laminating mold piezoelectric device 25 is carried out rapidly, shocking inertial force will occur, the above-mentioned static-friction force will be overcome, and a needle 26 will slide on the inside of a pipe 24. Then, if the laminating mold piezoelectric device 25 is shrunk gently, a needle 26 stops sliding and fixes a location within a pipe 24 according to the above-mentioned static-friction force.

[0021] Contrary to this, after carrying out contraction actuation of the laminating mold piezoelectric device 25 rapidly, a needle 26 can be moved to hard flow by making it elongate gently. Hereafter, actuation of the above-mentioned direct-acting actuator is explained to a detail.

[0022] As shown in drawing 4, when a trapezoidal wave electrical potential difference is impressed to the laminating mold piezoelectric device 25, to the timing of I and III to start in drawing, the laminating mold piezoelectric device 25 develops rapidly. At this time, a needle 26 and the laminating mold piezoelectric device 25 move to hard flow rapidly mutually, and impulse force occurs according to the laminating mold piezoelectric device 25 in coincidence. The impulse force generated by this laminating mold piezoelectric device 25 is transmitted to a needle 26, overcomes the static-friction force, and drives a needle 26. Thereby, it pushes and a needle 26 is moved so that a slider 27 may be struck through the elastic material 38.

[0023] Then, in II in drawing, and the timing section of IV, since the electrical potential difference impressed to the laminating mold piezoelectric device 25 is reduced gradually and the die length of the laminating mold piezoelectric device 25 contracts gently, while a motion of a needle 26 is prevented by the frictional force of laminating mold piezoelectric-device 25 peripheral face and pipe 24 inner skin, only laminating mold piezoelectric-device 25 self is pulled back.

[0024] By repeating such a process, a slider 27 will slide within a pipe 24 and the die length of a link 23 will be elongated. That is, a needle 26 is held by friction with pipe 24 inner skin, starts migration from the time of inertial force exceeding the maximum static-friction force, and when it is less than kinetic frictional force, it comes to stop.

[0025] Pressurization can be applied from a spring 33. such a link 23 -- a movable plate 21 and a stationary plate 22 -- it did and above-mentioned drawing 2 showed -- as -- a slider 27 -- a coupling rod 28 -- minding -- a swivel joint 29 -- the inside of housing 34 -- pressurization -- a plate 32 and pressurization -- the same -- a pipe 24 -- a coupling rod 30 -- minding -- a swivel joint 31 -- the inside of housing 37 -- pressurization -- a plate 35 and pressurization -- since pressurization can be applied and it connects respectively free [rotation] from the spring 36, the structure of having six degrees of freedom by the link 23 of one is realizable.

[0026] Moreover, it is also possible to replace with a trapezoidal wave electrical potential difference as shown by above-mentioned drawing 3, and to impress a full-wave-rectification wave electrical potential difference as shown in drawing 4. In this case, an output, i.e., the force of telescopic motion in a link 23, can be increased further.

[0027] If the direct-acting actuator of the link 23 for which it asks by considering as the structure of the link 23 concerning the gestalt of this 1st operation is driven and that link 23 is made to expand and contract as shown above, in order that [of each links 23 and 23 and --] a movable plate 21 may have a location and six degrees of freedom of a posture controlled and may change that location and a posture according to the amount of telescopic motion, telescopic motion of the required link 23 will be performed.

[0028] The above-mentioned direct-acting actuator does not have a limit in the movable range, and can be set up sufficiently long according to the die length of a pipe 24. Moreover, the activity range can be set up widely sharply, miniaturizing the whole equipment from the manipulator of the parallel link mechanism driven by telescopic motion of the conventional piezoelectric device, since the configuration of the direct-acting actuator itself is very small. It becomes easy to realize as a micromanipulator which performs the activity which follows, for example, carries out the detailed assembly of the minute object under a microscope, and manipulation.

[0029] (Gestalt of the 2nd operation) The micromanipulator of the parallel link mold applied to the gestalt of operation of the 2nd of this invention below is explained with reference to a drawing.

[0030] In addition, since it is the same as that of what was explained by above-mentioned drawing 1 about the whole configuration, the same part shall attach the same sign and shall omit the illustration and explanation. Furthermore, since the same is fundamentally said of the concrete configuration of a link 23 as shown in drawing 5, the same part shall attach the same sign and the explanation shall be omitted.

[0031] A deer is carried out and fixed arrangement of the inertial field 40 is carried out at the other end side which has not formed the needle 26 of the laminating mold piezoelectric device 25. Since the impulse force produced in case it elongates rapidly with the electrical potential difference to which the laminating mold piezoelectric device 25 was impressed was increased, this inertial field 40 was formed, and thereby, it can carry out an adjustable setup of the amount of inertia related to the movement magnitude of a needle 26 directly. Therefore, an adjustable setup of the amount of flexible steps and flexible rate of a direct-acting actuator can be carried out at arbitration.

[0032] Hereafter, actuation of the above-mentioned direct-acting actuator is explained to a detail. As shown in drawing 6, when a trapezoidal wave electrical potential difference is impressed to the laminating mold piezoelectric device 25, to the timing of V and VII to start in drawing, the laminating mold piezoelectric device 25 develops rapidly. At this time, a needle 26 and the laminating mold piezoelectric device 25 move to hard flow rapidly mutually, and impulse force occurs according to the laminating mold piezoelectric device 25 which formed the inertial field 40 in coincidence. The mass of an inertial field 40 was considered, and the impulse force generated by this laminating mold piezoelectric device 25 is transmitted to a needle 26, overcomes the static-friction force easily, and drives a needle 26. Thereby, it pushes and a needle 26 is moved so that a slider 27 may be strongly struck through the elastic material 38.

[0033] Then, in VI in drawing, and the timing section of VIII, since the electrical potential difference impressed to the laminating mold piezoelectric device 25 is reduced gradually and the die length of the laminating mold piezoelectric device 25 contracts gently, while a motion of a needle 26 is prevented by the frictional force of laminating mold piezoelectric-device 25 peripheral face and pipe 24 inner skin, only laminating mold piezoelectric-device 25 self is pulled back.

[0034] By repeating such a process, a slider 27 will slide within a pipe 24 and the die length of a link 23 will be elongated. That is, a needle 26 is held by friction with pipe 24 inner skin, starts migration from the time of inertial force exceeding the maximum static-friction force, and when it is less than kinetic frictional force, it comes to stop.

[0035] Contrary to this, after carrying out contraction actuation of the laminating mold piezoelectric device 25 rapidly, a needle 26 can be moved to hard flow by making it elongate gently. Since this inertial force is what was seasoned with the mass of the above-mentioned inertial field 40, the flexible rate at the time of being able to make it increase as compared with the case of the thing of a configuration of that above-mentioned drawing 2 showed the inertial field 40, the amount of flexible steps, i.e., amount, which slides at once, consequently driving repeatedly can be made to increase.

[0036] Therefore, an adjustable setup of the flexible rate of a direct-acting actuator can be carried out now at arbitration by carrying out adjustable [of the mass], although it is used as an inertial field 40. In addition, this invention is not restricted to the gestalt of the above 1st and the 2nd implementation, and it considers as what has possible deforming variously and carrying out within limits which do not deviate from the summary.

[0037]

[Effect of the Invention] Having a configuration like invention according to claim 1, then high resolution, since the direct-acting actuator which constitutes the link which does not receive a limit in the movable range and connects a movable plate and a stationary plate is small, the whole manipulator can be miniaturized.

[0038] Since an adjustable setup of the amount of inertia related to the movement magnitude of the above-mentioned needle can be carried out directly in addition to the effect of the invention of a

configuration like invention according to claim 2, then the claim 1 above-mentioned publication, an adjustable setup of the amount of flexible steps and flexible rate of the above-mentioned direct-acting actuator can be carried out as a result at arbitration.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The perspective view showing the configuration of the whole concerning the gestalt of operation of the 1st of this invention.

[Drawing 2] Drawing showing the cross-section structure of the link concerning the gestalt of this operation.

[Drawing 3] Drawing showing the applied-voltage wave to a laminating mold piezoelectric device and the actuation of a direct-acting actuator concerning the gestalt of this operation.

[Drawing 4] Drawing which illustrates other applied-voltage waves to the laminating mold piezoelectric device concerning the gestalt of this operation.

[Drawing 5] Drawing showing the cross-section structure of the link concerning the gestalt of operation of the 2nd of this invention.

[Drawing 6] Drawing showing the applied-voltage wave to a laminating mold piezoelectric device and the actuation of a direct-acting actuator concerning the gestalt of this operation.

[Drawing 7] The perspective view showing the configuration of the micromanipulator by the general parallel link mechanism.

[Description of Notations]

- 11 -- Movable plate
- 12 -- Stationary plate
- 13 -- Link
- 14 -- Hand
- 15 -- Laminating mold piezoelectric device
- 16 -- Strain gage
- 20 -- Hand
- 21 -- Movable plate
- 22 -- Stationary plate
- 23 -- Link
- 24 -- Pipe
- 25 -- Laminating mold piezoelectric device
- 26 -- Needle
- 27 -- Slider
- 28 30 -- Coupling rod
- 29 31 -- Swivel joint
- 32 and 35 -- pressurization -- a plate
- 33 and 36 -- pressurization -- a spring
- 34 37 -- Housing
- 38 -- Elastic material
- 39 -- Elastic spring foot
- 40 -- Inertial field

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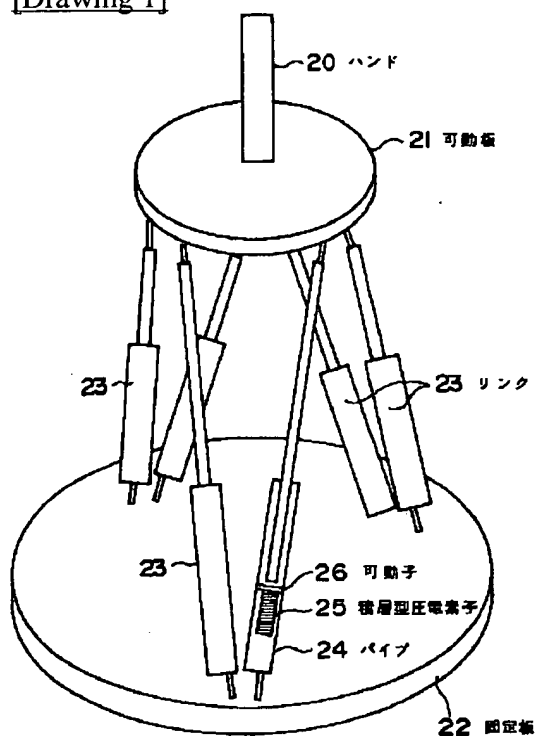
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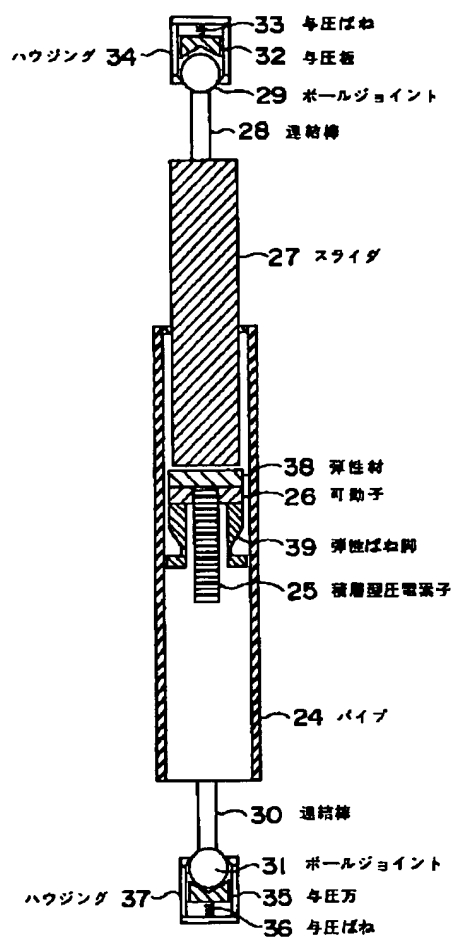
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DRAWINGS

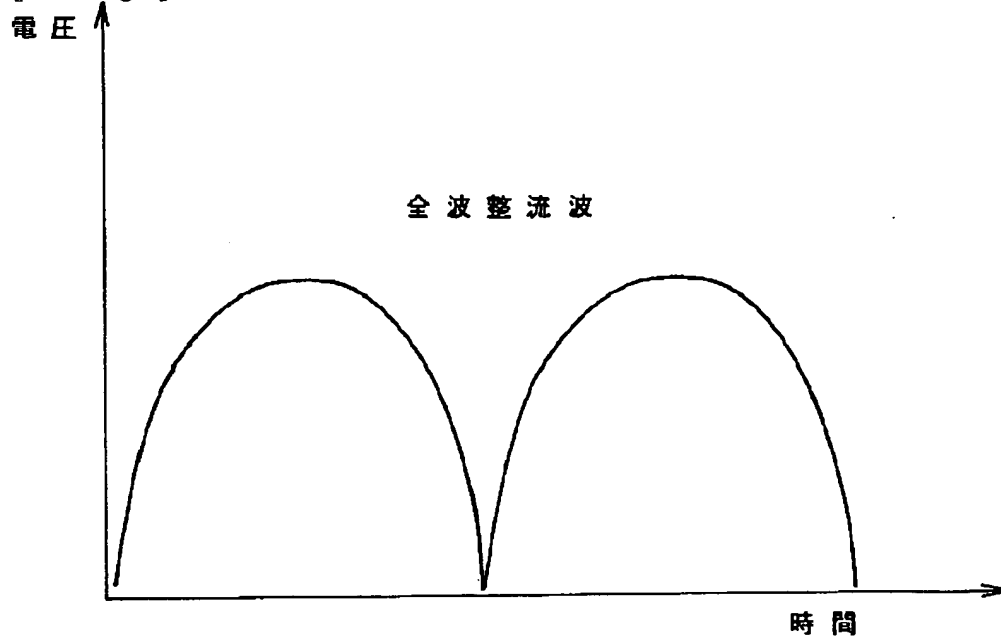
[Drawing 1]



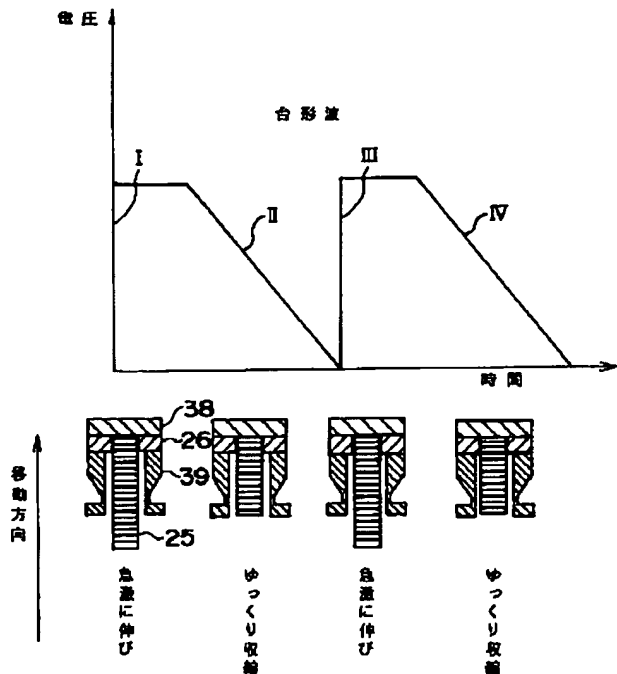
[Drawing 2]



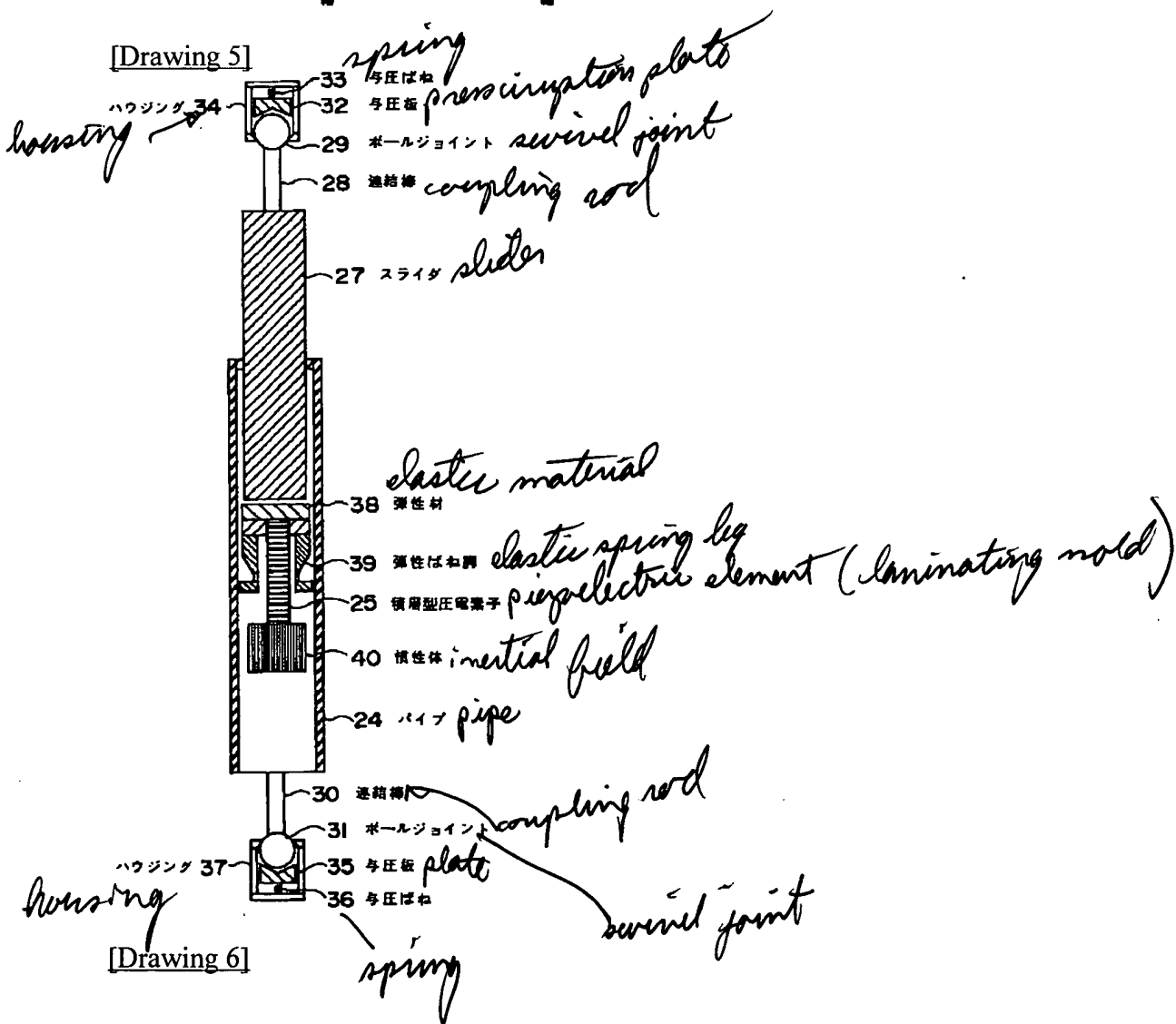
[Drawing 4]



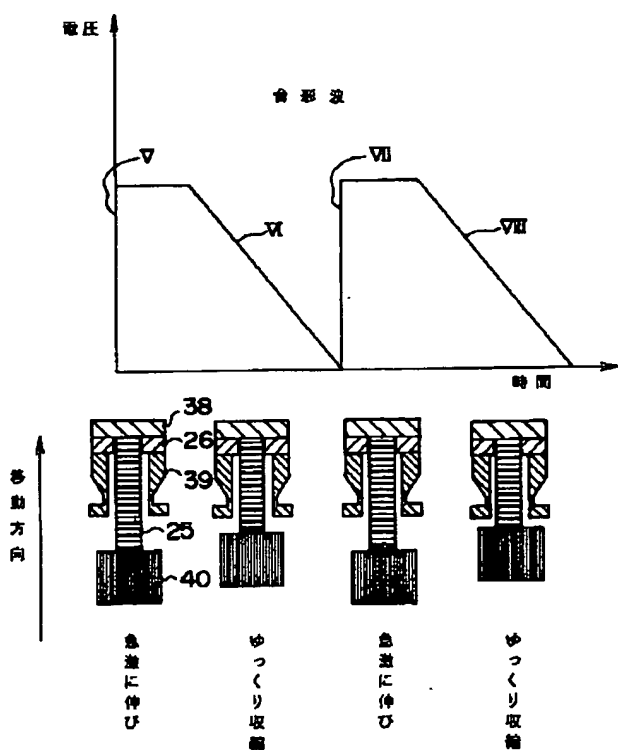
[Drawing 3]



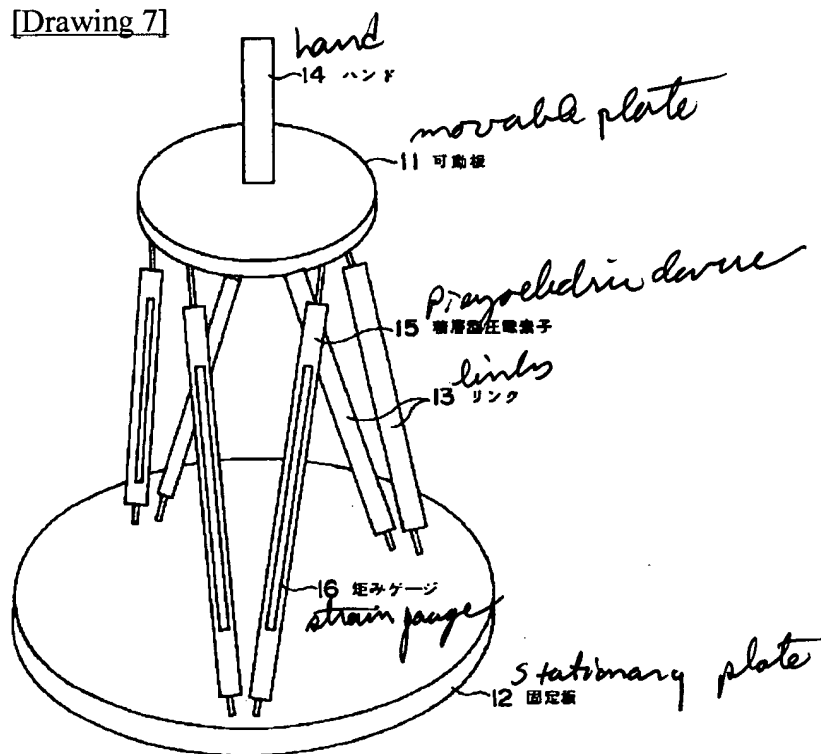
[Drawing 5]



[Drawing 6]



[Drawing 7]



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